QST

DEVOTED ENTIRELY TO

AMATEUR RADIO

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Kenneth B. Warner (Secretary, A.R.R.L.), ***Editor-in-Chief and Business Manager***

James J. Lamb *Technical Editor* — **George Grammer** *Assistant Technical Editor* — **Clark C. Rodimon** *Managing Editor*

David H. Houghton *Circulation Manager* — **G. Donald Meserve** *Advertising Manager*

Advertising Offices.................................**55 West 42d Street, New York City**
Editorial Offices.................................**1711 Park Street, Hartford**

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EDITORIALS

THIS issue of *QST* reaches members on the eve of elections for director in half of the A.R.R.L. divisions. It is the time of year when we members of the League must do a bit of serious thinking for the welfare of our organization. "These elections," as the printed announcements say, "are the constitutional opportunity for members to put the man of their choice in office as the representative of their division."

Too many of us, we fear, are ignoring a certain responsibility of A.R.R.L. membership. Civic affairs frequently suffer because many citizens shirk their responsibility at election time. Surely we are deeply enough interested in our amateur radio and its organization to warrant the expenditure of some constructive thinking once in two years. As we see it from headquarters, there are too many members of the League who make no effort to get a man of their own choice nominated for director, who make no effort to boost a candidate who is their idea of what a director ought to be, who don't even bother to vote in the elections, but who don't hesitate to complain at almost everything their directors do and who indiscriminately throw brickbats at a director they couldn't be troubled about nominating, electing or advising. If these members, instead of "kicking" over what an already-elected director does, would put this same amount of energy into looking over the men in their division, picking out a really good one, backing him with some work and effort, and generally take part in League affairs before the election, everything would be much sweeter.

The reader, as an individual member of the League, ought to make it his business to back and vote for a candidate who stands for the things the member wants to see in A.R.R.L. That is the basic idea in our system of government. That gives the greatest available assurance that the director thus chosen will be representative of majority opinion on important amateur topics in his division. "These elections are the constitutional opportunity for members to put the man of their choice in office as the representative of their division."

It is of the utmost importance, too, that the League have good intelligent direction. It is vital to the life of amateur radio in this country. The next two years are really of tremendous importance in our future. This future, this welfare of amateur radio in the years to come, depends upon the quality of the judgment which our Board of Directors can bring to bear on our problems. It is up to you members, then, to send *good* directors to the Board, men chosen not so much because they suit your prejudices on certain amateur problems as because they can add to the depth of vision of the Board — men whose ability you respect, whose judgment you will be willing to trust when they assume their responsibility of directing the work of our League.

Remember that the Board "runs the League" but that you select the members of the Board. Theirs is a heavy responsibility but so is yours. Our League is now a large organization, its affairs are of considerable magnitude. The success of the idea of "representative government" in this League would seem in the long run to hinge upon the willingness of each member to give serious thought to the abilities of the directors in whose hands he places the future of his organization. A.R.R.L. "rates" the best direction we members can give it — men of experience, knowledge, wisdom, intelligence and vision!

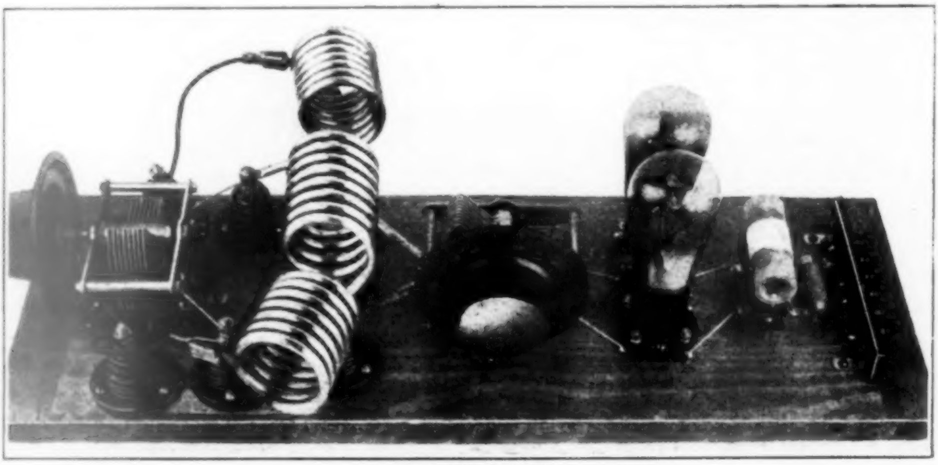
K. B. W.

A Complete Push-Pull C.W. Transmitter at Low Cost

By George Grammer, Assistant Technical Editor

IT'S an easy job to build up a low-power transmitter of the conventional pattern using a Type '10 tube as an oscillator with a pair of Type '81 rectifiers working from a 550-volt transformer. It's likewise easy to put together an oscillator using a small receiving tube and a few "B" batteries or a "B" eliminator for plate supply. The first outfit will cost around \$80.00 (list prices) complete with tubes and the necessary accessories, even without allowing anything for the two or three meters which ought to possible to build a transmitter using a Type '10 tube for the same price as the "B" battery outfit, but it *is* possible to build a transmitter with as much power output as the '10 will give, the cost of which will be about half-way between the two.

This transmitter, illustrated in the photographs, is built almost entirely of receiving equipment which is readily obtainable; and the cost of all the necessary parts, including the key, is approximately \$45. A milliammeter to read plate current, the use of which is strongly recom-



THE TRANSMITTER

The circuit is the push-pull tuned-plate tuned-grid, with a fixed resonant grid coil. The oscillator tubes are Type '45's. The arrangement of the parts is explained in the text.

be included in an amateur transmitter — but it will "get out" and get plenty of DX with any kind of intelligent handling. The second one is satisfyingly cheap — but the power output is so low that the station is practically out of the running if competition from other stations is bad.

The tendency toward a sort of standardization among broadcast receiver manufacturers, remote though such a movement would seem to be from amateur radio, has resulted in a lowering of prices on the tubes most commonly used, notably the Type '45 and the Type '80, and concurrently a fairly low level of prices on power supply equipment designed to be used with those tubes. The immediate effect of this, so far as the amateur is concerned, is to help bring together the two extremes cited in the first paragraph. It is not yet mended, will add seven or eight dollars more to the cost. In these examples, of course, the prices given are list, not those which are quoted by bargain houses. It is certainly true that by judicious buying it is easily possible to reduce the cost of the set to \$35 or less.

And the set is not a toy or another flea-power outfit — it is intended for practical communication, and will do anything the typical Type '10 outfit sketched at the opening of this story will do — and perhaps do it better. It will put just about the same amount of power into an antenna that the '10 outfit will — and with better frequency stability. The push-pull circuit takes care of the latter.

When the Type '45 tube was first introduced it was labelled "not intended to be used as an

oscillator," and most amateurs, remembering bitter experiences with the Type '50, were inclined to believe it. Whatever the intentions may have been, however, the fact is that the '45 is a very good oscillator, exhibiting none of the characteristics which made the '50 infamous. Having made this statement, we suppose that by the time this *QST* is out a week we'll have at least seven letters telling us we're all wet, because the writers personally tried out the tubes with only a thousand volts on the plate and they (the tubes, of course) blew up. If that happens all we can do is write back, "So they ought." It is a fact, however, that a number of the tubes have stood up for continuous runs with 400 volts and more on the plates without showing any signs of an early demise or losing their ability to oscillate. Strange to say, the '45 at 400 volts and less gives more output than the '10 with the same plate voltage. This was found to be invariably true in a number of test set-ups in the laboratory. But don't get the idea on that account that the '45 is a better tube than the '10 — it won't stand the voltage that the '10 will by any means. The point we wish to bring out is this — *two* '45's in a push-pull transmitter with about 350 volts d.c. on the plate will give as much output with as good frequency stability, as *one* Type '10 with 600 volts d.c. on the plate (the usual voltage from a 550-volt transformer with a good filter and normal load on the tube). And the cost is a whole lot less. The latter point is the important one. Aside from that, the r.f. portion of this transmitter can be used with a pair of Type '10 tubes as well as with '45's, with quite an increase in output if the '10's are run with the normal power supply used with those tubes.

BUILDING THE TRANSMITTER

Getting down to constructional details, the circuit will be recognized to be essentially that of the 150-watt transmitter in June, *QST*, with a few simplifications. A fixed-tune grid coil is incorporated in the transmitter in place of the usual tuned circuit, and the antenna tuning system has been changed to eliminate one condenser. All circuit elements which could possibly be dispensed with have been eliminated from the set.

The baseboards for both the transmitter and power supply are both the same size, each being half of an 18 x 26 breadboard. They are sandpapered smooth and given three coats of Duco clear lacquer, with a little smoothing treatment with fine sandpaper between each coat. Rubber "bumpers" are used as feet, one at each corner of the baseboard.

Most of the transmitter parts are mounted on top of the baseboard. From left to right are the antenna tuning condenser, a pair of standoff insulators to which the antenna or feeder connections are made, another pair of standoff insulators which support the antenna coupling coils, and a third pair of insulators supporting the plate coils of the transmitter. Next in line is the tank tuning condenser, the tubes and their sockets, the grid coil and mounting, the grid leak, and finally, the binding post strips for connections. The photo of the under side of the transmitter baseboard shows the radio-frequency choke coil in the positive high-voltage lead, the filament center-tapped resistor, the filament by-pass condensers, and the wiring to the connection strip.

The layout shown is about the most logical for a push-pull transmitter, and allows connections to be symmetrical. In fact, the transmitter is laid out in exactly the same way as the schematic diagram in Fig. 1, except, of course, that the connections have been brought out to the end of the board instead of one side of it, as the schematic diagram would indicate. The wiring underneath the baseboard has been kept as near to the center of the board as possible to keep it away from

THE POWER SUPPLY

Utilizing a Type '80 rectifier, a broadcast power-pack transformer and choke, and a double-section electrolytic condenser.

strong r.f. fields. The center-tapped resistor across the filaments is connected at the mid-points of the wires joining the filament connections on the tube sockets. A home-made strap of thin brass holds the wires, which are No. 14 rubber covered, in place. The r.f. choke coil in the

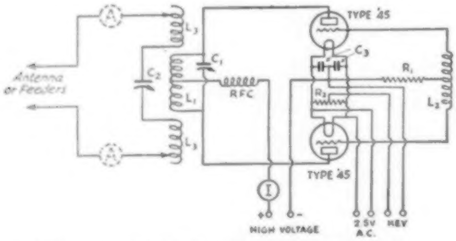


FIG. 1. — THE TRANSMITTER CIRCUIT

Showing series antenna tuning.
C_1 — 500 μμfd.
C_2 — 350 or 500 μμfd.
C_3 — 250 μμfd.
R_1 — 50,000 ohms.
R_2 — 20-ohm center-tapped resistor.
RFC — Two-inch winding of No. 36 d.s.c. on half-inch form.
L_1 — 3500 kc. — 12 turns of ¼-inch copper tubing 2⅜" inside diameter.
7000 kc. — 8 turns of ¼-inch copper tubing 1⅝" inside diameter.
14,000 kc. — 4 turns of ¼-inch copper tubing 1⅝" inside diameter.
L_2 — 3500 kc. — 72 turns No. 32 s.s.c. on 1" form.
7000 kc. — 40 turns No. 28 d.c.c. on 1" form.
14,000 kc. — 16 turns No. 28 d.c.c. on 1" form.
L_3 — 7 turns of ¼" copper tubing 1⅝" inside diameter.
I — 0-150 d.c. milliammeter or 6-volt flashlight bulb.
A — 0–1 thermocouple ammeters — these are not entirely necessary but are helpful in tuning.

plate lead is connected to a brass bolt which comes through the baseboard, and should be installed as near the plate coil as possible, but at right-angles to it.

The grid coils are wound on rigid insulating forms 1" in outside diameter, and no spacing is used between turns. These coils, together with the plate coils accompanying them, are shown in another photograph. The coils are mounted on General Radio Type 274-BP plug assemblies, and the socket is a Type 274-BJ three-jack assembly. These assemblies are very convenient, although a dollar or so can be saved by using G.R. jacks and plugs and mounting them on bits of hard rubber or bakelite in a similar fashion. In winding the coils it should be remembered that a change in the wire size, or even a change in the type of insulation on the same size of wire, will make necessary a different number of turns. If the diameter of the wire, including insulation, is smaller than that given, less turns will be needed, and vice-versa. The correct number of turns is easily found if a plate milliammeter is available, and the adjustment will be described later. Be sure that the same number of turns is used on each side of the center tap. When the coil is completed it should be "doped" to prevent loosening of the turns and to keep out moisture.

Connections between the grid coil socket and the grid posts on the tube sockets, and also between the tuning condenser and the plate posts on the tube sockets, are made with ordinary bus wire, since these wires do not have to carry heavy currents. The connections between the tuning condenser and the insulators which support the plate coil, however, must be made of the same size of copper tubing used for the plate coil, because these connections are part of the tank circuit and heavy currents flow in them. In placing the tuning condenser and the insulators be sure that both of the copper-tubing connectors are the same length from the connections on the condenser to the insulators, to make certain that the tank circuit is symmetrical.

The insulators which hold the plate coil are spaced 4½ inches between centers. The coils are wound to fit on the insulators, and the spacing between turns can be judged by an inspection of the photograph. The 3500-kc. coil is wound on a piece of pipe with an outside diameter of 2⅜ inches, while all the other coils are wound on pipe 1⅝ inches in outside diameter. Each of the plate coils must have an even number of turns so that the clip for the center tap can be placed on the under side of the coil. A brass machine screw is run through the baseboard midway between the insulators holding the plate coil, and a nickel-plated battery clip is connected to the screw by a short length of flexible wire. When the coil is fastened to the insulator the clip is placed on the center turn.

The antenna coils are wound on 1⅝-inch pipe, one end of the coil being brought out so that the axis of the coil will line up with the axis of the plate coil when fastened in place. Be sure to wind both antenna coils in the same direction. If wound in opposite directions the fields will "buck," and the antenna will not take power from the transmitter. The antenna coils shown have seven turns each, but the exact number to use will depend on the type of antenna system employed. These coils will be satisfactory with a Zeppelin antenna on all bands if the feeders are between 45 and 50 feet long.

The coils will keep a pleasing bright finish if they are carefully cleaned and lacquered. Before winding each coil, the necessary length of tubing should be thoroughly scoured with steel wool. After the coil is finished and the spacing between turns adjusted correctly, it should again be touched up with steel wool and then scrubbed with a rag soaked in alcohol to remove grease. When dry, Duco lacquer, preferably thinned out considerably with the thinner which comes for that purpose, should be painted on with a small brush, making certain that the entire surface is covered, and then allowed to dry thoroughly before the coil is put in service. If the coils are not

lacquered they will oxidize in a day or two. This is particularly true of the plate coils, which get appreciably warm in operation, and if not lacquered will turn a muddy brown color in a very short time.

In building the transmitter be certain to use exactly the same values for the circuit elements as are specified in Fig. 1. They are the ones which were found to be best after a considerable period of experimentation.

THE POWER SUPPLY

There is nothing unusual about the power-supply unit, except that the output voltage is somewhat lower than that commonly employed in low-power transmitters. The high-voltage winding of the power transformer furnishes 350 volts each side of the center tap, which is rectified by the Type '80 tube, and then fed into the filter. The latter is a brute-force arrangement, using a double-section dry electrolytic condenser and a 30-henry choke. Each of the condenser sections is rated at 8 μfd. and will stand 500 volts peak. The peak voltage of the transformer output is safely within this rating. An actual test of the power supply unit showed that the no-load voltage delivered by the rectifier and filter was between 450 and 500, dropping to about 350 volts under a load current of 100 milliamperes, the normal current taken by the transmitter when delivering power to the antenna.

The power transformer is of the type often used in broadcast receivers, and in addition to the high-voltage winding has a 5-volt winding for the filament of the Type '80 rectifier and two 2.5-volt windings, one of which is used to light the filaments of the Type '45 tubes in the transmitter, the other being left idle.

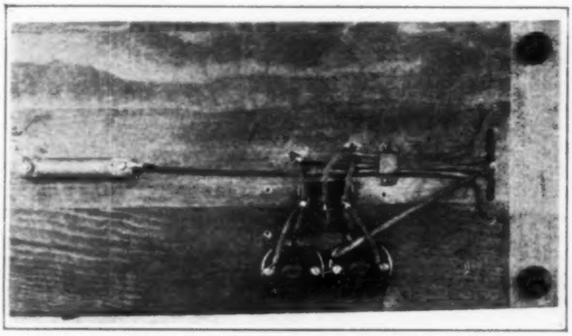
All of the wiring is above the baseboard in the power supply. No. 14 rubber-covered wire is used for connections, the insulation effectively preventing short-circuits. A double-pole single-throw switch for tuning the line voltage on and off, and a cord and plug for making connections to the house current complete the outfit.

When using electrolytic filter condensers be sure to connect them in the circuit with the polarities correct. The outside can is usually the negative connection, the positives being the binding posts on top. Instructions usually accompany the condenser.

With this power supply it is easily possible to get a pure d.c. note on all bands if the transmitter is well built and properly adjusted. If the d.c. note is not forthcoming look to the transmitter itself and not the power supply — this same trouble was encountered in working out the details of this outfit and it can be overcome with a little patience.

GETTING INTO OPERATION

There is nothing more hopeless than trying to adjust a transmitter without the means of knowing just what effect each change made has on the frequency, note and output. Two things at the very least are necessary — a monitor and some sort of indicator for telling when the antenna is taking load. The monitor should be used in conjunction with a frequency meter, or at least should be calibrated so that it is possible to tell with certainty whether the transmitter is in the band or not. Radio-frequency ammeters in the feeder leads are useful for determining when the antenna is tuned correctly, but the plate milliammeter is the handiest all-around meter to have, because with it the input power can be estimated and it can be used to indicate resonance with the antenna. By its use it is also possible to tell whether the tubes in the set are being overloaded or not. A 6-volt flashlight bulb or dial-light may be substituted for the milliammeter and will serve as a resonance indicator, although the actual plate current cannot be read in this case.



THE WIRING UNDERNEATH THE BASEBOARD

The plate choke, filament center-tap resistor and filament by-pass condensers are shown in this photograph. Note that the condensers and resistor are connected to the midpoints of the wires joining the filament connections on the tube sockets.

Suppose now that the monitor is ready for use and that a milliammeter or bulb is connected in the positive high-voltage lead to the transmitter. The transmitter is to work on the 3500-kc. band for this illustration. The proper coils are in place and all connections are tight.

First make sure that the antenna or feeders are disconnected and that the antenna coupling coils are moved as far from the plate coil as possible. Set the plate tuning condenser at maximum and close the key. The milliammeter reading should be somewhere between 25 and 45 milliamperes. Slowly turn the plate condenser, watching the milliammeter at the same time, and see if the plate current decreases to a minimum at some reading and then begins to rise again. This dip should occur at very near full capacity on the

condenser, and if it is very far down the scale a few turns should be added to each side of the grid coil. This is, in fact, the way to adjust the grid coil in a circuit of this sort. The number of turns on the grid coil should be such that the minimum point on the plate current reading (with the antenna not coupled to the oscillator) occurs at a frequency slightly lower than the low-frequency end of the band on which that coil is supposed to work. Without some means of checking frequency it is apparent that an intelligent adjustment of the coil cannot be made.

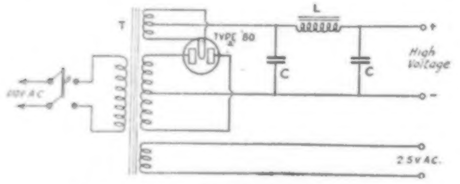


FIG. 2. — THE POWER-SUPPLY UNIT

T — Power transformer. Should have high-voltage winding giving at least 350 and not more than 400 volts each side of center tap, a 5-volt center-tapped winding for the filament of the Type '80 rectifier, and a 2.5-volt winding to supply the filaments of the transmitting tubes.

L — 10-to 30-henry choke with 100-milliampere or greater current-carrying capacity.

C — 8-μfd. filter condensers. The one shown in the photograph is an electrolytic condenser consisting of two 8-μfd. sections.

If the transmitter does not oscillate the plate current reading will be quite high — 150 to 200 milliamperes. Reasons for non-oscillation might be: grid coil turns not adjusted correctly; center tap on grid coil or plate coil not on electrical center; bad tubes, or low filament voltage. Ordinarily, however, if the circuit specifications are followed exactly there will be no trouble in getting the transmitter to oscillate.

Now set the tuning condenser at the point which gives the lowest plate current reading and check the frequency and the quality of the signal. The note should be pure d.c. and very steady, and the frequency should be very near 3500 kc. Next choose the frequency on which the transmitter is to be operated (this will naturally be the resonance frequency of the Hertz antenna, if such is used) and tune the transmitter to that frequency.

Now set the antenna coupling coils so that the distance between each of them and the plate coil is about an inch to an inch and a half. Both coils should be exactly the same distance from the plate coil. If the Zeppelin type of antenna is used and the feeders are between 45 and 50 feet long the parallel tuning connection shown in Fig. 3 should be used. The feeders should be clipped on the two insulators to which the antenna tuning condenser is connected, and a jumper should be connected between the two insulators to which the flexible leads which connect to the antenna coils are fastened. Now turn the antenna tuning condenser until the milliammeter or bulb shows the maximum plate current is flowing. The frequency and character of the note should next be checked with the monitor, and if the former has changed appreciably a readjustment of the plate condenser to bring it back to the proper place should be made. This will also necessitate retuning the antenna condenser. If the note shows signs of ripple the antenna condenser should be tuned a little off resonance until the note clears up again, or the antenna coils may be moved a little farther away from the plate coil. The correct adjustment will be that at which the antenna takes the most load with the note remaining steady and pure — the character of the note is more important than the current put into the antenna, because high antenna current is useless unless the signal is clean and steady.

The method of adjustment on the 7000- and 14,000-kc. bands is similar, except that series antenna tuning, as shown in Fig. 1, is used with the 45-foot feeders assumed. Other feeder lengths or differing antenna types will require different handling, and as the number of combinations is rather large it is impossible to cover all of them. The *Handbook* shows methods of tuning with practically all types of antennas in common use among amateurs, and should be consulted for further information if the builder is not familiar with antenna tuning systems. The proper setting of the plate tuning condenser will be at approximately 75% of full capacity on 7000 kc. and 60% on 14,000 kc.

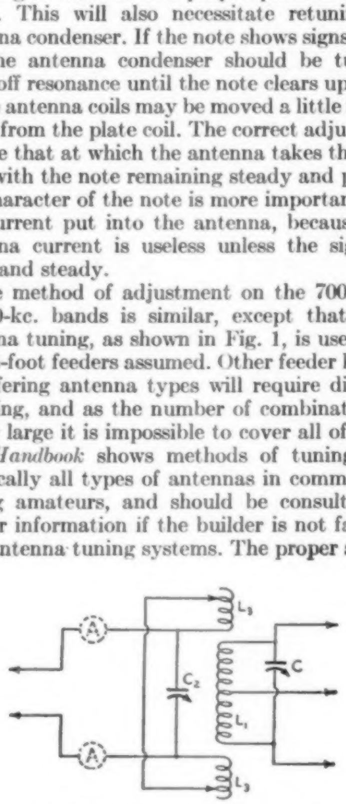


FIG. 3. — CONNECTIONS FOR PARALLEL ANTENNA TUNING

The feeders are connected directly across the antenna condenser and the clip connections on the coupling coils tied together. The remainder of the circuit diagram is the same as Fig. 1. The antenna ammeters are again optional.

The output obtainable will vary somewhat with the frequency, as is the case with all vacuum-tube oscillators, but tests with a dummy antenna have shown that it can be expected to at least equal that obtainable from a typical single Type '10 with similar values and circuit conditions on corresponding frequencies. The stability seems to be better than the '10 will give, probably because of the use of the push-pull circuit.

The r.f. ammeters indicated in Figs. 1 and 3 will be found useful for tuning purposes, although

not altogether necessary. The antenna current values are really meaningless, and if the meters are used the transmitter and antenna tuning should be adjusted so that the current through both is the same, regardless of the actual value of that current. A scale of 0–1 ampere will be sufficient for a set of this power.

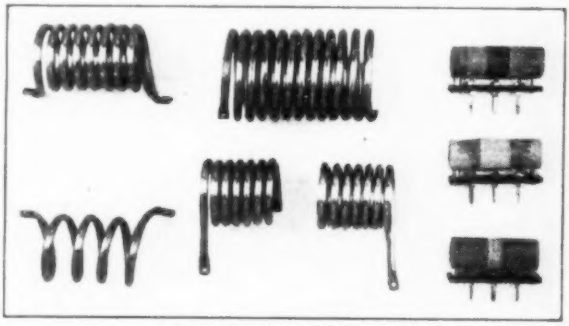
SOME TROUBLES

One of the worst problems encountered in building the set was that of eliminating unwanted r.f. in the power supply. R.f. wandering back into the power transformer and filter always makes itself known by roughening up the note — the blame for which is usually placed on the filter. The d.c. returns to the grid and plate in this circuit are fed in at a point of minimum r.f. voltage so that no chokes would seem to be required. This is true so far as the fundamental frequency is concerned, but unfortunately, as pointed out in the September "Uncle Jimmy" story, the second harmonic flows in these leads with much gusto unless something is done to prevent it. This happened with this transmitter and led to some rather curious results.

In an experimental "haywire" layout first built up for the purpose of testing out the '45's, a generator was used to supply plate voltage so the voltage could be readily adjusted, and the filament winding on a "B" supply furnished the filament power. The set was reduced to the bare essentials — no chokes or by-pass condensers were in it at all — and consisted of a plate coil, plate tuning condenser, two tubes, an untuned grid coil and a grid leak. A dummy antenna was used for a load. No trouble was experienced in getting a very good d.c. note on 14,000 kc. with this rig, even though no attempt was made to filter out the commutator ripple of the generator.

Next the outfit shown in the photographs was built up, but without any chokes or by-pass condensers in the transmitter itself. The 2.5-volt winding on the power transformer had no center tap, and since no center-tapped resistor was handy at the time, the filament supply used with the experimental set — which *was* center-tapped — was used temporarily. The power-supply unit shown furnished the plate power, however. This set performed in exactly the same way as the first one, which naturally was expected. In the meantime the center-tapped resistor arrived from downtown and was installed in the set — and then our troubles commenced. Using the 2.5-volt winding on the power transformer, the set simply would not give a d.c. note on any of the three bands — yet as soon as a separate filament supply was used the note became d.c. again.

Checking on the monitor showed that a strong second harmonic was present, and the inference was that this harmonic was getting back to the power transformer through the filament wiring and thus into the plate-supply system. With a separate filament transformer it was probably "washed out" in the line before it could get back to the plate supply. 500-$\mu\mu$fd. by-pass condensers were then tried across the filament, and on 3500 kc. the note immediately changed to pure d.c. On 14,000 kc., however, the note was much worse with the by-pass condensers than without them. This didn't look so good, so the next thing tried was a small choke in the positive lead, leaving off



THE TRANSMITTER COILS

The two copper-tubing coils on the left are the 7000-kc. and 14,000-kc. plate coils. The large coil in the center is the 3500-kc. plate coil, and the two below it are the antenna coupling coils. The grid coils for the three bands are at the right.

the by-pass condensers. The note immediately changed to d.c. on 14,000 kc., which was highly encouraging, but back on 3500 kc. there was still a noticeable ripple, although less than without the choke. A larger choke (the one shown in the photograph) was next tried with some improvement on 3500-kc. and no change in the d.c. on 14,000 kc. No larger chokes were available, so the filament by-pass condensers were tried again, this time with the choke in the circuit, and the note was again pure d.c. on 3500 kc. But again there was some ripple on 14,000 kc.

Finally 250-$\mu\mu$fd. condensers were substituted for the 500-$\mu\mu$fd. size which we had been using, and this capacity proved to be large enough, in conjunction with the choke, to give the desired d.c. note on 3500 kc., and still small enough not to upset things on 14,000 kc. On 7000 kc. this combination functioned equally well. With a good-enough choke the by-pass condensers could probably be eliminated on all bands — and if a separate filament transformer is used for the oscillator filaments neither choke nor condensers are necessary. Certainly there are more things than the filter alone to be considered in getting that elusive d.c. note on high frequencies.

INCREASING POWER

The fact that Type '10 tubes can be used in the set has been mentioned previously. The power output can be considerably increased by using a pair of '10's with about 600 volts on the plate, although there is no advantage in using these tubes with the power supply illustrated — rather the opposite. It may be found desirable to change the size of the grid coils slightly to get the best results with Type '10 tubes, and the method of adjustment already described should be followed. No changes in the other values are necessary, except that a 10,000-ohm leak would allow slightly greater output. The high-resistance leak specified for the '45's is necessary because greater bias is required for efficient operation, the amplification factor of the '45 being less than half that of the '10.

The set is an excellent one for the beginner just as it is, giving as it does a reasonable amount of power output with excellent frequency stability. If higher power is desired later, the money invested is not wasted, because this outfit forms an ideal master-oscillator to feed a pair of amplifier tubes. The output is more than ample to swing a pair of Type '10 tubes with 750 volts on the plates as a neutralized amplifier, and although we have not had an opportunity to try it with larger tubes, should be capable of feeding a pair of '03-A's or '52's to give normal output. Use of the outfit as a master oscillator is highly recommended, because the effect of a swinging antenna on the frequency is eliminated, and since a separate power supply for the oscillator is available the regulation under load conditions is good. In addition, the separately-excited amplifiers will give more output and can be adjusted for greater efficiency than when the same tubes are used as oscillators.

Central Division Convention

(Ohio State)

THE convention this year was held at the Dayton Biltmore Hotel in Dayton, Ohio. Officially the dates were the 30th and 31st of August; however, on the 29th several of the early comers got together in true ham fashion and held a private party the evening of the 29th and friendships were made and renewed before the actual convention. Saturday, delegates arrived from all Ohio and surrounding states and before lunch there were 150 registrations, which gave promise to be a well attended affair.

K. B. Warner and C. C. Rodimon of A.R.R.L. Headquarters appeared on the scene early and trips to the famous Wright Airport were made by some of the delegates while others preferred to visit the Van Horne tube factory or the General Motors Radio Corp.

After lunch the convention was officially opened when Mr. "Art." John, president of the Dayton Amateur Radio Assn., sponsors of this year's convention, welcomed the delegation and was followed in turn by Mayor MacDonald. Director D. J. Angus then gave the fellows a "handshake" and introduced Secretary-Editor Warner and C. C. Rodimon, W1SZ. Short talks were then given by George Morton on "Condenser Microphones"; W. T. Walter, of Jewell Elect. Inst. Co., about "Electrical Measuring Instruments and Their Application to Amateur Radio"; E. C. Estey, of Aluminum Co. of America, told about some of the high spots in the Toronto I. R. E. Convention and also of the "Application of Aluminum to Amateur Radio"; C. H. Vincent, W8RD, spoke on "Aircraft Radio Communication" and H. F. Breckel gave a Naval Reserve talk.

After dinner the gang assembled and listened to talks by F. R. Finehout, E. Springer, J. R. Martin and F. H. Schnell. Schnell of Radio and Television Inst., Chicago, did not have a chance to finish his talk, so it was finished with illustrated slides after the banquet on the following evening. After adjournment Saturday evening, informal chats were held here and there around the hotel until listeners, gradually overcome by the strenuous day, were forced to retire.

Sunday morning a good attendance was noted at the Traffic Meeting. This meeting was presided over by Director Angus and several points that were heretofore hazy were cleared up to the satisfaction of all those present. After this spirited meeting those present assembled out doors and had a group photo taken.

During the afternoon most of the fellows took the trip out to Mason, Ohio, to give WLW-WSAI the once over. The 'phone men were in their element at this Mecca.

All assembled back at the hotel for the great event of the convention — the banquet. The final registration was 201 and when all were seated at the banquet tables there were about 250 present. After a delicious dinner, entertainment and the general hilarity had settled down Director Angus acted as toastmaster and all hands entered in and gave a hand to the Program Committee and D.A.R.A. for one mighty fine convention. Mr. Warner talked on amateur matters and regulations. This was followed by talks from C. C. Rodimon and H. F. Breckel. Mr. Schnell then finished his talk on a superheterodyne receiver. After the prize drawing of some seventy prizes and the 'phone and c.w. men had a general open meeting the curtain was lowered on one more of these amateur conventions which are getting to be more and more cosmopolitan. Mr. L. E. Furrow, W8IX, and his helpers on various committees are to be congratulated on the enjoyable meetings and get-togethers.

—C. C. R.

Something New in Receiver Design

By C. R. Stevens*

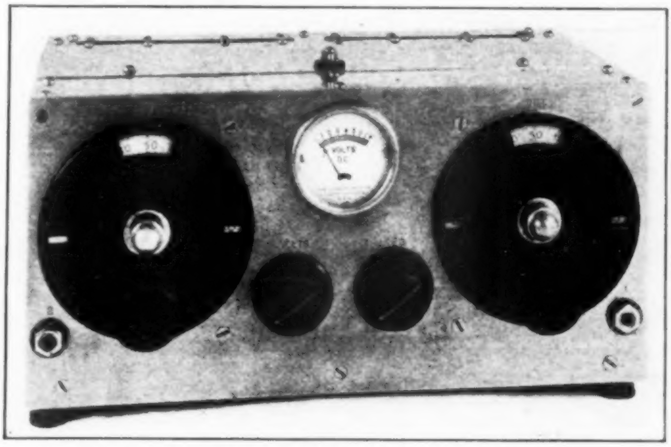
A SENSITIVE, selective and rugged high-frequency receiver capable of power output sufficient to operate a loud speaker need not be much more bulky than the usual ham receiver having lesser qualifications, and the receiver described in this article demonstrates just how one can be built. Although the set is extremely compact, measuring but 12″ long by 5¾″ high by 6¾″ deep, it contains six tubes in a circuit combination having unusual and attractive features. The receiver was designed with the peculiar problems of high-frequency reception in mind and none was overlooked during the six months required for the set's development. The result is a receiver that has excellent selectivity, although free of the usual critical adjustments, and delivers loud-speaker performance on any frequency between 37,500 and 1500 kc. (8 and 200 meters).

The set is designed for d.c. operation and comprises a stage of tuned radio-frequency amplification preceded by an aperiodic coupling stage, a special two-tube detector, and two stages of audio.

The circuit of the receiver is shown in Fig. 1 and the arrangement of the components is shown in the illustrations.

The antenna coupling stage uses a Type '22 tube with its grid circuit untuned and its plate circuit impedance coupled to the tuned grid circuit of the following r.f. stage. The tuned r.f. amplifier also uses a Type '22 tube.

The most unusual circuit feature of the receiver is the detector arrangement. This consists of two tubes, one of which acts as the oscillator and does the regenerating while the other functions only as a detector. This circuit arrangement was suggested in the Experimenters' Section, *QST*, March, 1930. The regeneration tube is a



COMPACTNESS AND RIGID MECHANICAL CONSTRUCTION ARE FEATURES OF THIS RECEIVER

The tuning control at the left is that of the radio-frequency stage and that at the right is for the detector. The meter indicates filament voltage. Beneath it are the filament rheostat and regeneration control knobs. The jacks are for 'phones or loud speaker.

COIL TABLE

Freq. Range	Diam.	Wire Size L_1, L_2	Wire Size L_3	Number of Turns L_1	Number of Turns L_2	Number of Turns L_3
37.5 to 15 mc.	1″	No. 16	No. 28	5	3	5
16.7 to 10 mc.	1″	No. 16	No. 28	7	5	7
10.7 to 6 mc.	1⅜″	No. 16	No. 28	11	8	9
6.5 to 4 mc.	1⅜″	No. 20	No. 32	16	11	10
4.35 to 3.3 mc.	1½″	No. 22	No. 32	24	14	12
3.5 to 2.2 mc.	1½″	No. 22	No. 32	30	20	13
2.4 to 1.8 mc.	1½″	No. 22	No. 32	37	27	16

The 1″ diameter coils are wound on tubing of this size mounted on the bottom of a UX tube base. The 1⅜″ coils are wound on tube-bases. The 1½″ forms are No. 131 Silver-Marshall. All coils are wound in the same direction with the tickler windings at the filament ends of the grid windings and spaced ⅛″ from the latter. There is no spacing between turns. The wire may be enamel covered, cotton and enamel, d.c.c. or d.s.c.

*P. O. Box 494, Waterbury, Conn.

Type '01-A and the detector tube is a Type '00-A. Regeneration is controlled by a 200,000-ohm variable resistor in the supply lead to the makes possible the operation of the detector tube at the values of plate voltage and grid-leak resistance which give greatest sensitivity and at

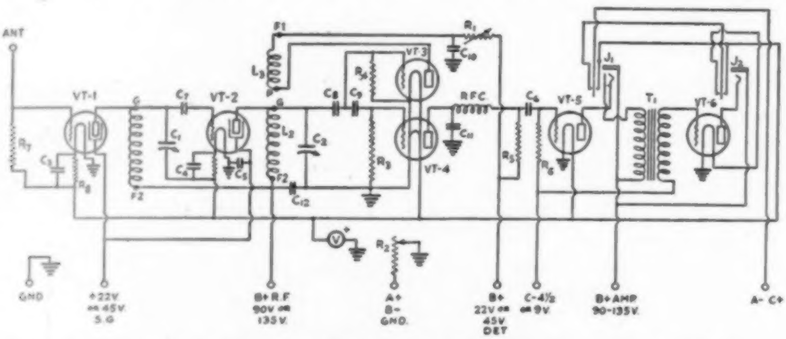


FIG. 1 — THE SEPARATE TUBES FOR REGENERATION AND DETECTION MAKE THE CIRCUIT "DIFFERENT"

L_1, L_2 and L_3 — See coil table.
C_1 — No. 317 Silver-Marshall condenser with 3 rotary and 2 stationary plates.
C_2 — Same as C_1 but with 4 rotor and 3 stator plates.
C_3, C_4, C_5 and C_6 — .01-μfd. fixed condensers.
C_7, C_8 and C_9 — 150-μμfd. fixed condensers.
C_{10} — .001-μfd. fixed condenser.
C_{11} — 500-μμfd. fixed condenser.
C_{12} — .25-μfd. fixed condenser.
R_1 — 200,000-ohm Centralab regeneration control.
R_2 — 6-ohm rheostat.
R_3 — 7-meg. leak.
R_4 — 10-meg. leak.
R_5 — 1.5-meg. leak.
R_6 — 3-meg. leak.
R_7 — 150,000-ohm Durham resistor, 1 watt.
R_8, R_9 — 10-ohm fixed resistors.
VT_1, VT_2 — Type '22 r.f. amplifiers.
VT_3 — Type '01-A regenerator.
VT_4 — Type '00-A detector.
VT_5, VT_6 — Type '12-A audio amplifiers.
T_1 — Silver-Marshall No. 256 audio transformer.
J_1, J_2 — Filament control jacks.
RFC — 60 turns No. 32 d.c.c. scramble wound on ¾" diameter form.
V — Filament voltmeter, 0–6 or 0–7 volts d.c.

regenerator's plate. The separation of the functions of detection and regeneration has several outstanding advantages which make the use of an additional tube worth while. The arrangement the same time allows the adjustment of the oscillator for best regeneration and oscillation. This cannot be accomplished so readily with a single tube used as an autodyne detector because the conditions for best detection are not usually those for greatest regeneration and smoothest oscillation. Elimination of the detuning which usually accompanies adjustment of the regeneration control is also accomplished. This makes possible the accurate calibration of the receiver. Moreover, the hissing background peculiar to an oscillating detector is almost entirely absent. This is especially advantageous when both stages of audio are used for loud-speaker reception.

THE SPACE BEHIND THE PANEL IS COMPLETELY UTILIZED

The screen-grid tube in the center compartment is the antenna-coupling tube. The tuned r.f. stage is in the compartment at the right. The left-hand compartment contains the detector unit, the regenerator tube being the one at the right and the detector tube the one at the left. The two audio amplifier tubes are in the center compartment. The coupling lead between the tuned r.f. stage and the detector compartment is run beneath the base. Battery connections are made to the Yaxley terminal plate.

This detector arrangement can be built into sets using single-tube autodyne detectors by making slight modifications in the detector circuit. Commercial receivers such as the a.c. and d.c. Pilot Super-Wasp are especially suited to such modification.

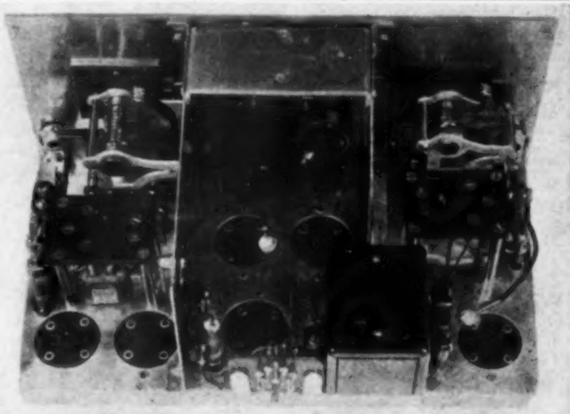
The detector is followed by two stages of audio-frequency amplification, the first being resistance coupled to the plate circuit of the detector and the second transformer coupled to the plate circuit of the preceding stage. Both audio stages use

Type '12-A tubes. Each stage is equipped with a filament-control jack so that one stage can be used for head-set reception and two stages for loud-speaker operation.

CONSTRUCTION

Mechanical design has been given just as much attention as the electrical features with the result that the receiver not only performs well but may be depended upon to continue doing so despite the more or less rough handling which any ham receiver must sometimes withstand. The apparatus is assembled on a heavy aluminum panel and sub-base which fit into the aluminum case. The aluminum panel is 12" long by 5¾" high by ⅛" thick and has mounted on it the two tuning condensers, the voltmeter, telephone jacks, the filament rheostat, and the regeneration control resistor. Particular care must be taken to insulate from the panel both filament control jacks (J_1 and J_2), the Centralab resistor (R_1) and the r.f. stage tuning condenser (C_1). The detector tuning condenser (C_2), which is at the right, and the filament rheostat (R_2) should not be insulated from the panel.

The unit is now ready for the mounting of parts on the sub-panel. The layout of parts is shown in the illustrations. In the rear view of the assembly the compartment in the center contains the screen-grid antenna coupling stage and audio tubes. To the right, separated by a 1/16-inch thick aluminum shield, is the tuned radio frequency stage. The audio transformer is mounted half in each compartment.

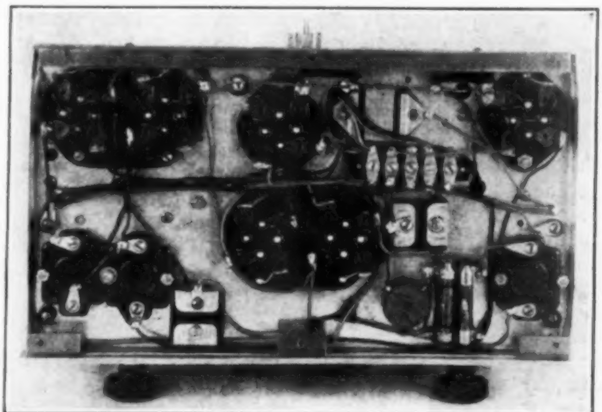


SUB-PANEL SOCKETS MAKE FOR ECONOMY IN SPACE

The plug-in coil mountings are elevated above the base board. The antenna connection is made to the insulated terminal on the shield between the center and left-hand compartments.

On the left, also separated by 1/16-inch shield from the antenna coupling compartment, is the two-tube detector compartment, the detector tube being the one at the left. This layout of parts was thoroughly tried out, and to avoid tube coupling this arrangement was found the most satisfactory.

Sub-panel sockets of the rigid type are used throughout and allow all wiring to be on the underside of the sub-panel, as are most of the condensers, resistors and chokes.



ALL CONNECTIONS TO TUBE-SOCKET TERMINALS ARE MADE BENEATH THE SUB-BASE

The detector sockets are at the upper left, the antenna coupling tube and audio tube sockets are in the center, and the tuned r.f. tube socket is at the right.

The plug-in coil sockets are raised 1¼ inches above the sub-panel, keeping the coils insulated as much as possible from other parts. A Yaxley No. 660 cable connector takes care of all battery leads. Any similar cable connectors having seven or more leads might be used. Care should be taken in wiring to have wires as short as possible, and to ground the "A+" and "B−" by the shortest path to the sub-panel.

The sub-panel is made from a piece of 1/16" aluminum sheet 12¾" long and 7½" wide. A ½" lip is turned up on all four edges, making the resultant dimensions 11¾" by 6½" by ½" deep.[1] The sub-panel is bolted to the front panel by three 6/32" flat head machine screws, 3/32" from the bottom and ⅛" from each end of the front panel.

After the unit is completed the next step is to construct a cabinet. Aluminum 1/16 inch thick was chosen as the ideal material. A piece of sheet iron is used as a stronger bottom. The two ends are cut first; one left, one right. Both are 6¼ inches by 6⅝ inches, each being bent ½ inch up from the 6¼-inch side to form a 90-degree angle,

[1] A good method of bending angles on aluminum sheet is desirable in *Building Shields, QST*, Nov., 1929. — EDITOR.

making them the same height as the panel, or $5\frac{3}{4}$ inches.

The back is then cut $11\frac{7}{8}$ inches by $6\frac{1}{4}$ inches and is also bent to form a right angle $\frac{1}{2}$ inch up on the long side, making it $11\frac{7}{8}$ inches by $5\frac{3}{4}$ inches.

Angle brackets cut out of brass $^1/_{16}$ inch thick are used to fasten the back and sides. These brackets are first fastened to the rear section at the extreme edges by $^6/_{32}$ round-head screws. Then the sides are fastened to the back so the edges come flush with the outside, using $^6/_{32}$ round-head screws.

THE COMPLETE SET OF COILS

The coils are arranged in pairs, the ones with two windings being the detector coils and those with the single winding the r.f. coils.

The bottom section can now be made, and added to the two sides and back. It is made of sheet iron $^1/_{16}$ inch thick and is $11\frac{3}{4}$ inches by $6\frac{1}{2}$ inches and is fastened to the two sides and back by $^6/_{32}$ round-head screws with the bends of the side and back sections on the underside of the bottom section.

The top of the cabinet is constructed of three pieces of $^1/_{16}$-inch (thick) aluminum, cut to the following sizes: 1 inch by 12 inches, 2 inches by 12 inches, and $3\frac{3}{4}$ inches by 12 inches. These are placed in the following way, covering the sides and back section: 1 inch by 12 inches, along the back lapping over the sides and back; 2 inches by 12 inches, along the front lapping over the sides, but even with the front edges of the side sections; the third piece, $3\frac{3}{4}$ inches by 12 inches, is fastened to the back strip by hinges, making a hinged lid which is very convenient for changing coils or tubes.

The ground binding post is fastened to the metal cabinet. The antenna binding post is insulated from the cabinet and a flexible wire connects it to the grid of the antenna coupling tube. The cabinet is then completed, and makes a very rigid, and compact container for the chassis.

After the assembly and wiring is completed, a thorough test is always a good "safety first" idea. It never pays to just say, "I think I have everything O.K." The simplest test method is by the use of a $4\frac{1}{2}$-volt "C" battery and a voltmeter. Proceed in the usual manner, noting particularly the following: Test all leads and terminals for any possible short circuit to the metal chassis or panel. Test all connectors that are grounded, and make sure they *are* grounded. Make a thorough examination of the condensers, C_1 and C_2, making absolutely sure that the movable plates do not touch the stationary plates in any position. A possible short at a point like this may prove very disastrous, especially in C_1.

Operation of this receiver is as easy as that of any two-dial receiver. In this circuit each control, radio frequency and detector tuning, shows the same amount of sharpness, a feature in itself giving extreme selectivity. The tuning is as sharp as that of the average superheterodyne circuit — and that's sharp! This sharpness is absent in many short-wave tuned radio frequency receivers, especially in the radio frequency stage. When the radio frequency stage is really sharp, incoming signals do not have the slightest tendency to hang on but really cut off as either dial is moved slightly. The receiver should not squeal or make any disagreeable noises while being tuned, but as both dials are brought into tune a slight "pluck" or "swish" — as is evident in a B.C. superhet — will be heard, disappearing upon the retarding adjustment of the regeneration control. Tuning is most satisfactory when the regeneration is just enough to show that the radio frequency stage and the detector stage are in resonance.

All amateur bands cover a large space on the dials. The 14,000-kc. band occupies 30 divisions, the 7000-kc. band 43 divisions and the 3500-kc band 70 divisions.

The New England Division Convention

(Maine Section)

THE Third Annual Maine Section Convention was held at Portland, Friday and Saturday, August 22nd and 23rd, under the very able auspices of the Portland Amateur Wireless Association.

Early morning of the 22nd found various members of the Convention Committee dashing hither and thither, busily engaged in "getting things organized" for the official opening of the first day's session. The registration booth was set up at the Eastland Hotel, and preparations for signing up the delegates were made. An amateur station was installed in the Sun Room of the hotel under the supervision of W1ATO, and was operated under his call. The Sun Room was a very popular

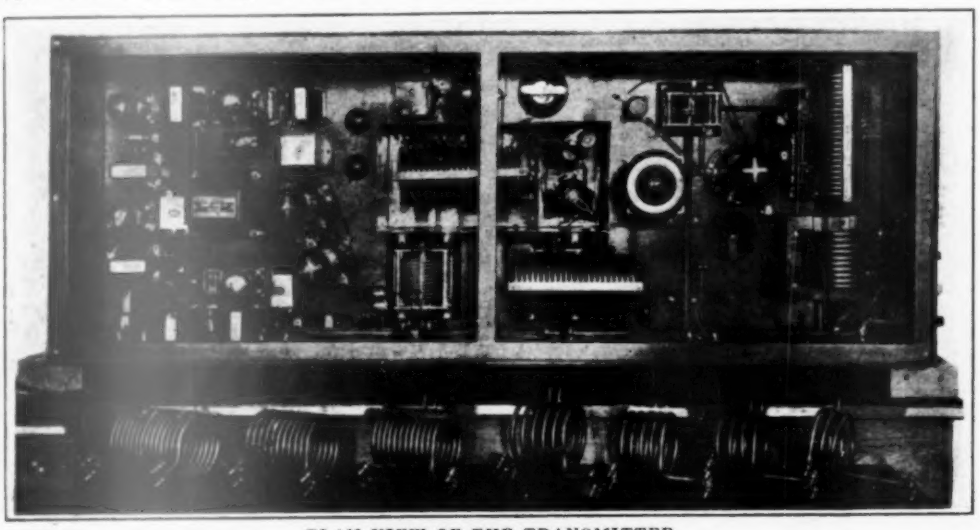
(Continued on page 80)

having a deck of ½" thickness mounted three inches up from the bottom, thus providing a space for the by-pass condensers, resistors, etc., as shown in the photograph of the under side of the set. The front panel is made up of four separate units of standard 7" x 24" x $^3/_{16}$" bakelite stock. The framework is made smaller than the panels so that the complete unit can be enclosed by a cover of ¼" wallboard. Both the framework and the wallboard cover are stained walnut and given two coats of shellac.

THE RADIO FREQUENCY SYSTEM

The radio frequency oscillator is a type Type '10 tube which may be crystal controlled plugs in parallel at each end to make the coils readily interchangeable. Two plugs in parallel at each terminal have been found quite satisfactory to handle the amount of power used in this transmitter.

The screen-grid Type '65 buffer stage is coupled to the oscillator by means of the midget variable condenser C_{13}. A variable condenser is used in this position so the magnitude of the excitation voltage on the grid of the buffer tube may be adjusted to the desired value without necessitating a variable tap on the oscillator plate circuit coil. The plate voltage of 500 volts for the buffer tube is obtained from the 1000-volt source through the series resistor R_{11}. The screen voltage



PLAN VIEW OF THE TRANSMITTER

Details of the assembly are given in the text.

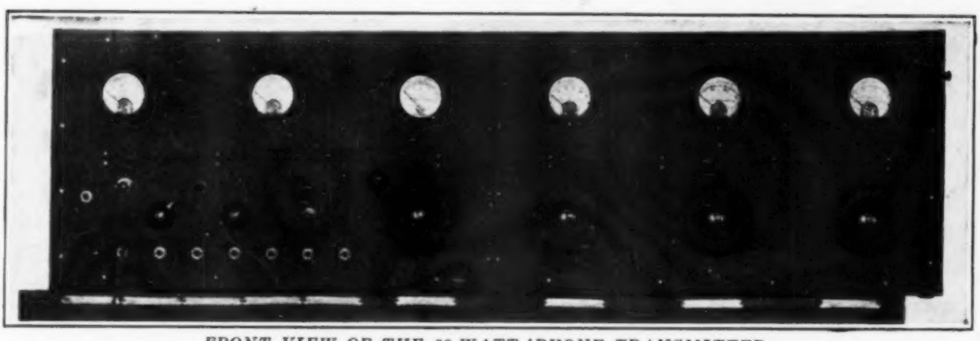
by plugging into its grid circuit a suitable quartz plate, or it may be operated as a self-excited Hartley oscillator by omitting the crystal and connecting the grid blocking condenser to the lower end of the tank coil L_4. This operation is quickly accomplished by a plug arrangement. The filament tap is placed on L_4 at the point for proper operation as a self-excited oscillator and does not need to be changed when operating with the crystal. The plate power is obtained from a 1000-volt source and is reduced to about 250 volts by means of the series resistor R_{10}. It was found that this low plate voltage was more than sufficient to provide adequate output to excite the grid of the buffer amplifier tube. A milliammeter M_3 indicates the plate current of the oscillator tube. The tank circuit of the oscillator, as well as that of the buffer and the power amplifier, is composed of a 230-$\mu\mu$fd. National transmitting variable condenser C_{10} and an inductance wound of ¼" copper tubing. These inductances are each fitted with two G.R. is obtained by using a potentiometer arrangement which is provided by the resistors R_{12} and R_{13}. This method of obtaining the desired screen voltage from the plate supply has been found much more satisfactory than the use of a series resistor, as sometimes recommended. The screen or plate current may be read by plugging a milliammeter into jacks J_8 or J_9 respectively.

To take advantage of the isolation afforded by the screen-grid buffer tube between the oscillator and the power amplifier, it is necessary to provide adequate shielding between these circuits. For this a shield of 35 mil sheet copper is provided for the portion of the circuit which comprises the oscillator output and the buffer input circuits. It was found that this was all the shielding necessary to effectively prevent disturbances in the power amplifier circuits reacting upon the oscillator. This copper shield, as well as the copper tubing inductors, were polished and given a coat of clear lacquer to keep them bright and to prevent a possible increase in the radio

A Modern 50-Watt Radiophone Transmitter*

By Howard A. Chinn and Paul S. Hendricks †

DURING the past year it became evident that a modern radiophone transmitter for operation on the amateur and experimental frequencies between 3000 and 17,000 kilocycles would be an useful addition to the equipment of the Round Hill Research Laboratories which are sponsored by Colonel E. H. R. Green and under the direction of the Massachusetts Institute of Technology, at South Dartmouth, Massachusetts. The apparatus was desired for communication with field parties, with itinerant aircraft and for experimental work in connection with the transmission and utilization of standard audio frequencies.



FRONT VIEW OF THE 50-WATT 'PHONE TRANSMITTER

After a careful survey of the many transmitter circuit arrangements possible, it was decided to design and construct a transmitter having a carrier output of fifty watts and capable of high percentage modulation with a good overall audio frequency characteristic. If it was found desirable or necessary to obtain a greater output power a linear radio frequency amplifier could be added at any time. The complete arrangement of tubes finally adopted is outlined in Fig. 1.

The radio frequency circuits consist of a Type '10 oscillator, a Type '65 buffer amplifier and a Type '11 output amplifier. The oscillator tube is arranged to be used as a crystal controlled tube if a quartz plate of the desired frequency is available or as a self-controlled oscillator when this is not the case. While the 7½-watt oscillator tube is capable of supplying enough energy to excite the 50-watt power amplifier directly without an intermediate stage of amplification, it is very difficult to maintain a constant frequency output from such an arrangement when the output tube is being modulated. An isolating or buffer-stage, employing a screen-grid tube is, therefore, used between the oscillator and the output amplifier. All tubes in the radio frequency circuits are thus operating at the same frequency.

Three stages of speech amplification employing two Type '12-A and one Type '50 tube are necessary so that a two-button carbon or a condenser microphone of the type common in broadcasting stations can be used. The condenser microphone itself usually has at least one stage of amplification incorporated in the microphone stand and this brings the output level of this unit up to that of the two button carbon microphone so that they are interchangeable. Both of these microphones, while capable of faithful electrical reproduction of the sound impinging upon the diaphragm, have a very low output level as compared to that of the ordinary single button microphone. If this latter type were to be used exclusively, a single stage of transformer coupled amplification would probably suffice to supply the grids of the modulators with the necessary audio frequency energy. A pair of UV-845 tubes connected in parallel is used to modulate the Type '11 radio frequency amplifier. This combination, with the particular circuit arrangement used, permits a high degree of modulation with relatively little distortion. A complete schematic diagram of the transmitter is given in Figs. 2 and 3.

The transmitter may be keyed for c.w. telegraph transmission by the usual methods.

The entire transmitter, exclusive of the power supply equipment and modulator reactors, is built into a single unit having an overall length of 48 inches, height of 14 inches and depth of 18 inches. The framework is of 1" x 1" whitewood

* Contribution from the Round Hill Research Division of the Massachusetts Institute of Technology.

† W1AXV-W1XP, Round Hill, South Dartmouth, Massachusetts.

frequency resistance when the surface became oxidized.

The Type '11 output power amplifier is excited from the buffer stage through the variable coupling condenser C_{14} which is a National transmitting condenser having a capacity of 230 $\mu\mu$fd. The

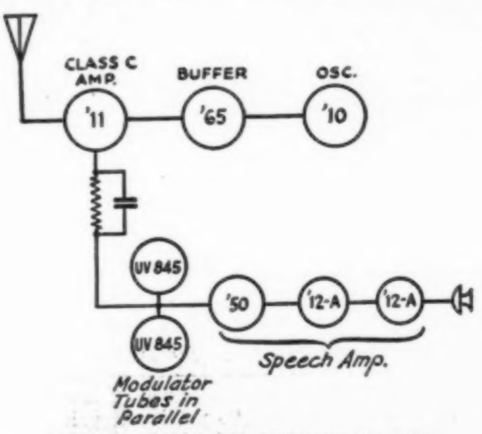
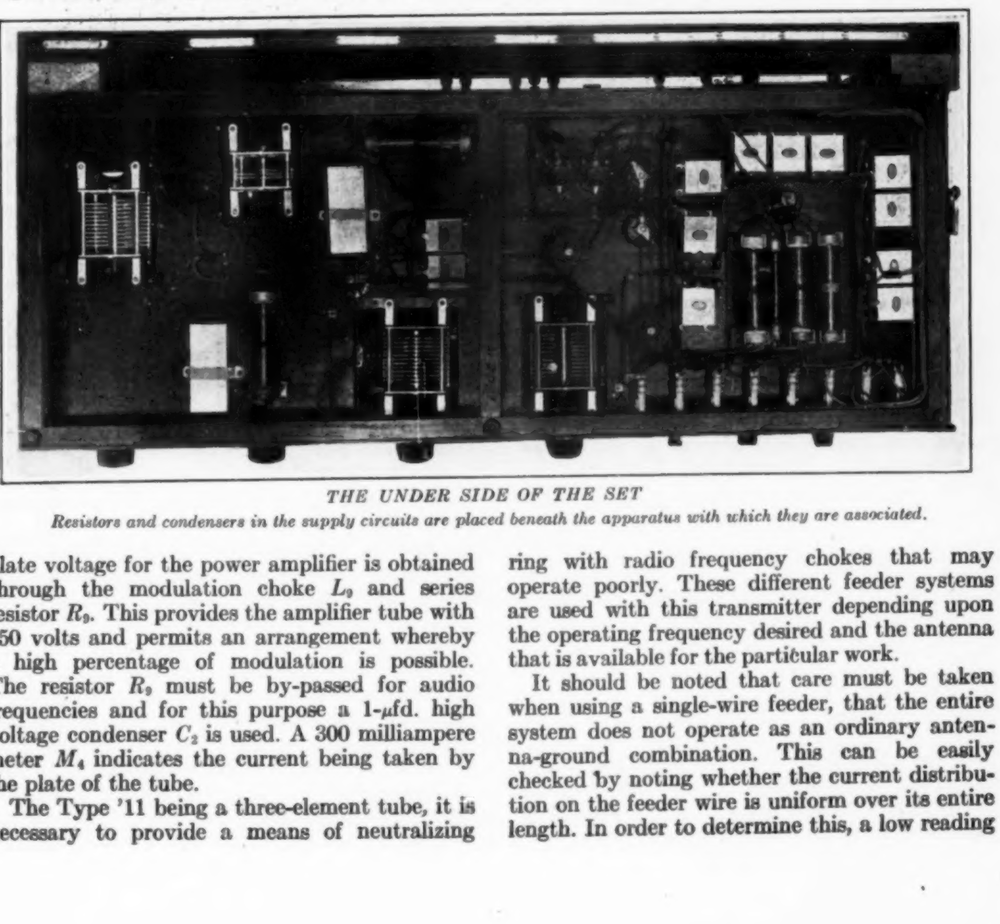


FIG. 1. — THE TUBE LINE-UP OF THE TRANSMITTER

this stage of radio frequency amplification. For this purpose a neutralizing condenser C_{15} (a National transmitting condenser of 50-$\mu\mu$fd. capacity) is connected between the grid of the tube and the lower end of its tank circuit coil. The radio frequency return, or high voltage tap, is then placed on the tank inductance at the point for proper operation of the tube, which is usually in the neighborhood of two-thirds of the way from the plate end of the coil.

Coupling to the antenna system, when using a quarter wave antenna and ground, is accomplished inductively by means of the 10-turn coil which is built into the set. This same coil is satisfactory when coupling by means of any two-wire feeder system and may also be used to couple a single-wire feeder inductively, by connecting one end of the coil to ground. The single-wire feeder system may also be used by tapping directly on the tank inductance, usually a turn or two towards the plate end of the coil from the filament tap. Inasmuch as series plate supply is used, it is advisable to put a blocking condenser in series with the feeder wire to keep the plate voltage off the antenna system. Series plate supply is consistently used throughout the transmitter because of the likelihood of trouble occurring with radio frequency chokes that may operate poorly. These different feeder systems are used with this transmitter depending upon the operating frequency desired and the antenna that is available for the particular work.



THE UNDER SIDE OF THE SET

Resistors and condensers in the supply circuits are placed beneath the apparatus with which they are associated.

plate voltage for the power amplifier is obtained through the modulation choke L_9 and series resistor R_8. This provides the amplifier tube with 750 volts and permits an arrangement whereby a high percentage of modulation is possible. The resistor R_8 must be by-passed for audio frequencies and for this purpose a 1-μfd. high voltage condenser C_2 is used. A 300 milliampere meter M_4 indicates the current being taken by the plate of the tube.

The Type '11 being a three-element tube, it is necessary to provide a means of neutralizing

It should be noted that care must be taken when using a single-wire feeder, that the entire system does not operate as an ordinary antenna-ground combination. This can be easily checked by noting whether the current distribution on the feeder wire is uniform over its entire length. In order to determine this, a low reading